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14. ABSTRACT
The cratering record on Tethys provides much-needed constraints on the formation timescale and mechanism of the mid-sized icy moons of Saturn. However, most geologic mapping studies have focused on the large impact basin, Odysseus, and the canyon system, Ithaca Chasma. Recently, work by the authors showed that ejecta fragments from primary impacts onto either of Tethys' coorbital moons are very likely to impact Tethys. The distribution, impact velocities, and impact angles of the debris are spatially-variable. In particular, high-velocity debris (>5 km/s) with low impact angles are highly clustered along the equator in Tethys' leading hemisphere. Slower impacts would be more evenly distributed across the surface of Tethys. Here, we use high resolution Cassini ISS images to look for impact features that may have resulted from coorbital debris, including elongated craters, grooves, and pit chains. In addition, we map features in two areas – one in which Schenk et al. would predict clustered, higher-velocity, oblique impacts and one on the opposite side of Tethys, where we would expect a sparser and more variable population of impactors.

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GEOMORPHOLOGY OF IMPACT FEATURES ON TETHYS USING HIGH RESOLUTION MOSAICS.

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Introduction: The cratering record on Tethys provides much-needed constraints on the formation timescale and mechanism of the mid-sized icy moons of Saturn. However, most geologic mapping studies have focused on the large impact basin, Odysseus, and the canyon system, Ithaca Chasma [1]. More detailed mapping studies reveal that Tethys' surface has a surplus of small impact craters [2]; regional variability in the small crater abundance implies a recent increase in small craters, likely from planetocentric impactors [1]. Recently, [3] showed that ejecta fragments from primary impacts onto either of Tethys' coorbital moons are very likely to impact Tethys. The distribution, impact velocities, and impact angles of the debris are spatially-variable. In particular, high-velocity debris (>5 km/s) with low impact angles are highly clustered along the equator in Tethys' leading hemisphere (see our companion abstract, Rhoden et al., 2017). Slower impacts would be more evenly distributed across the surface of Tethys. Here, we use high resolution *Cassini* ISS images [4] to look for impact features that may have resulted from coorbital debris, including elongated craters, grooves, and pit chains. In addition, we map features in two areas – one in which [3] would predict clustered, higher-velocity, oblique impacts and one on the opposite side of Tethys where we would expect a sparser and more variable population of impactors.

Methodology: Because we are interested in small craters and potential impact features, we focus on images with resolutions better than the current Tethys basemap, created by [5] and distributed by the USGS. This is the only complete basemap for Tethys, and it has a pixel scale of 293 m/pix. We create mosaics from the ISS images by first tying them into the basemap and then using the Integrated Software for Imagers and Spectrometers (ISIS3) [6] that is distributed by the USGS. In ISIS3, we apply all routines needed to properly map project the finished mosaic. The next step is to create a new control net to apply to each mosaic to ensure proper alignment of the images when they are mosaicked together. After the mosaic is generated, we project it to the coordinate system of the basemap to preserve location information after the mosaic is imported into ArcGIS.

In order to assess regional variability, and compare with the predictions of [3], we map features in two different regions. One is near the Odysseus impact basin, which we'll refer to as R1, and the other is located on the other side of Ithaca Chasma, R2. The central coordinates of the R1 mosaic are 15.12°S, 185.74°E; R2's center is at 6.955°N, 335.171°E.

Using ArcGIS, we visually inspect each mosaic to identify craters <20 km in diameter (see Rhoden et al., 2017), especially those with irregular shapes that could be the result of slow impacts. We also look for any grooves, scours, or pit chains that may have formed as a result of oblique impacts, as predicted by [3]. We map each observed feature using the tools in ArcGIS and using the Crater Helper [8] tool provided by the USGS to measure the ellipticity of the impact craters. We also measured the diameters of impact craters, lengths of linear features, and their azimuths. The small craters that were mapped appeared to be at the limit of resolution. This appeared to be when a feature was around 1.5 km in diameter. Scours were labeled as such if they appeared in a collective with other linear features and showed a topographic downslope. Grooves were mapped as more singular features and were not found in large groups like the scours were. Crater chains were defined as more than three craters all appearing to create a chain pattern. When identifying a crater as irregular, we looked for either an elongated shape or a segment of the rim that is straight.

Results: Our preliminary map of features in R1 is shown in Figure 1. Mapping of R2 is in progress. We find an abundance of scours that tend to concentrate in groups creating what appears to be a tectonic fabric. We also find some features that appear to be ridges and that cross-cut many of the other nearby features. There is a large pit chain that appears near the bottom of the mosaic, which is the largest pit chain identified in this map. Grooves appear away from the scours and less concentrated in groups.

We find 17 large, irregularly shaped craters, as shown in the magenta color in Figure 1. Small craters have currently only been mapped for the top sections of the mosaic; there are 224 at present count. Ejecta blankets from the larger craters superpose their surrounding terrain, suggesting that these impacts occurred later in this regions history. The presence of elongated craters suggest slow impacts, which are more consistent with coorbital debris impacts [3] than with heliocentric impactors [8].The observed grooves and pit chains are suggestive of the oblique impacts, which are also consistent with the predictions of [3]. More comprehensive mapping of both regions is required to draw meaningful conclusions about the source material that created these features and to test the prediction that faster, more oblique impacts should occur in R1 than R2.

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Figure 1. Preliminary map of the impact craters and tectonic features. Inlay of the basemap shows the location of the mosaic on Tethys (highlighted in yellow). Cassini ISS images that comprise this mosaic are N173137226_1, N173137436_1, N173137645_1, N173137849_1.